



## **Electrical Alternative Analysis**

## **Smith – West Garrard 345kV Transmission Line Project**

A Touchstone Energy<sup>®</sup> Cooperative 

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## **Introduction**

To accommodate load growth among its member cooperatives, EKPC plans to construct generating units at its J.K. Smith Power Station (J.K. Smith), located in the community of Trapp, in Clark County, KY. The site currently contains seven combustion turbine units (CT's) with a total generating capacity of 826 MW at winter capacity. Four existing 138-kilovolt transmission lines are currently connected to the J.K. Smith Substation. These lines are insufficient to accommodate delivery of any additional generation at an expanded J.K. Smith Power Station.

EKPC has proposed to construct 5 additional CT's at J.K. Smith. The first of these units is scheduled to become operational in March of 2008. The addition of this generation has created the necessity for additional transmission outlets from the facility. The Smith-West Garrard Transmission Line will provide the outlet necessary for the addition of the five combustion turbines (CT's) proposed for construction at J.K. Smith.

J.K. Smith has been the subject of two environmental impact statements (EIS) and three environmental assessments throughout the facilities history. Typically, the addition of CT's on an existing generation site has required the preparation of an environmental assessment with scoping requirements per USDA Rural Development regulations (7 CFR 1794). Due to the high level of environmental work that has been conducted on the J.K. Smith Power Station site and the amount of disturbance that has occurred on the site, USDA Rural Development has waived the scoping requirements associated with the preparation of an environmental assessment for the CT's (per 7 CFR 1794).

The Smith – West Garrard Transmission Line Project is being evaluated in a separate environmental assessment with scoping requirements than the CT's. USDA Rural Development allowed this classification of the project since the J.K. Smith site has already been studied extensively and the level of environmental review for the transmission line remains at a high level. USDA Rural Development has not waived the scoping requirements for this project.

A System Impact Study (SIS) was prepared to evaluate the transmission facilities needed to provide the necessary capacity for addition of these units. EKPC also included a 278 MW Circulating Fluidized Bed Steam Generator that has been proposed for construction in the study. EKPC felt it would be prudent to include future needs such as this generator when planning proposed transmission to ensure constructed lines would be able to accommodate future load. The environmental impacts of the 278 MW Circulating Fluidized Bed Steam Generator will be analyzed in an Environmental Impact Statement separate from the Smith-West Garrard Transmission Line Project.

## **System Impact Study**

The SIS report was entitled: "System Impact Study, Generation Interconnection Requests #30-33, JK Smith Combustion Turbines #8-12 and CFB Unit #1 Project In Clark County, Kentucky." A copy of the full SIS is available on the USDA Rural Development

website: <http://www.usda.gov/rus/water/ees/ea.htm>. The report evaluates the impact of the addition of the following generators at EKPC's existing J.K. Smith Power Plant:

- a) Five (5) combustion turbines, each with a net capacity of 84 MW in the summer and 98 MW in the winter. These units will be designated as J.K. Smith CTs #8, #9, #10, #11, and #12.
- b) One (1) Circulating Fluidized Bed (CFB) steam generator with a net capacity of 278 MW in both summer and winter. This unit will be designated as J.K. Smith CFB #1 throughout this report.

<b>J.K. Smith Planned Generation Additions</b>			
<b>Requested Project</b>	<b>Commercial Operation Date</b>	<b>Summer Net Capacity (MW)</b>	<b>Winter Net Capacity (MW)</b>
JK Smith #12	March 2008	84	98
JK Smith #11	April 2008	84	98
JK Smith #10	October 2008	84	98
JK Smith #9	November 2008	84	98
JK Smith #8	December 2008	84	98
JK Smith CFB #1	March 2010	278	278

The existing four 138 kV transmission lines connected to the J.K. Smith Substation are insufficient to accommodate delivery of the total net output of the expanded J.K. Smith Power Plant. In fact, it was determined that the existing transmission outlets cannot accommodate any generation additions at the site. Therefore, the study identified various transmission expansion plans needed to support the total expected output of the expanded J.K. Smith site.

Input was solicited from EKPC's neighboring utilities -- American Electric Power (AEP), Big Rivers Electric Corporation (BREC), Cinergy Corporation (CIN), Dayton Power & Light Company (DPL), LG&E Energy LLC (LGEE), the Tennessee Valley Authority (TVA), and the Midwest Independent System Operator (MISO) -- prior to beginning the SIS.

Thirty-eight possible 345 kV or 138 kV transmission outlets from the J.K. Smith Substation were evaluated to determine their impacts on the thermal overloads identified. The screening process eliminated most of these outlet options for one of the following two reasons:

- An outlet either singularly or in combination with other outlets did not eliminate a substantial number of the thermal overloads caused by the proposed generators

- An outlet did not provide any significant additional benefits when compared to the performance of another outlet that would be shorter and/or less expensive

As a result of the screening analysis, it was determined that one 138 kV outlet from the J.K. Smith site would not be adequate. Screening showed that at least **three** 138 kV outlets would be required to accommodate the added generation. Additionally, significant upgrades would still be required on the transmission system with these multiple 138 kV outlets. Furthermore, transmission-system losses will be higher with these 138 kV outlet options than with a 345 kV outlet option. For these reasons, no options were considered that only provided 138 kV outlets from J.K. Smith Substation. All transmission alternatives considered therefore included a new 345 kV outlet from the J.K. Smith site.

The screening analysis performed determined that two of the 345 kV outlet options considered have a greater impact on the transmission-system problems identified than did the remainder of the outlet options. These two outlet options are:

- ✓ The J.K. Smith-Tyner 345 kV line and the installation of a 345-161 kV transformer at Tyner
- ✓ The J.K. Smith-West Garrard 345 kV line and a new 345 kV switching station at West Garrard connecting this line with LGEE's Brown-Pineville 345 kV circuit

These two outlets substantially reduce the number and severity of overloads caused by the proposed generators. The other outlet options screened either did not provide as much benefit as either of these two options or provided similar benefits at the expense of much more construction.

## Alternatives Considered

Alternatives are desired that eliminate the overloads of the facilities impacted by addition of the generators. Furthermore, since all four of the existing 138 kV outlets from the J.K. Smith Station are overloaded, the alternatives developed must either upgrade all four of these outlets or establish at least one new outlet from the J.K. Smith Station.

### Impact of J.K. Smith-North Clark Proposed Project on Alternatives to be Considered

Concurrently with this J.K. Smith SIS, EKPC conducted a parallel study to identify a solution for existing transmission-system problems. The results of that parallel study are documented in a document developed by EKPC titled *Justification of J.K. Smith-Sideview 345 kV Line*, dated October 31, 2005. [Note that the Sideview endpoint was later re-named North Clark]. The recommended solution from that study was to construct a new 345 kV breaker substation, install 345 kV facilities at the J.K. Smith Substation to accommodate a new line exit, install a new 345-138 kV, 450 MVA autotransformer at the

J.K. Smith Substation, and construct 18 miles of 345 kV line between the J.K. Smith Substation and the new North Clark Substation

This recommended construction addresses the problems of the existing transmission system. It also provides some benefits for the proposed generators that are the subject of this SIS. However, power flow analysis with the J.K. Smith-North Clark Project added to the models indicates that transmission-system overloads would still exist with the proposed generators. Therefore, alternatives must be developed that incorporate the planned J.K. Smith-North Clark Project while still addressing overloads identified neighboring facilities. Therefore, as stated above, the alternatives developed must either include capacity upgrades for the four existing 138 kV outlets from the J.K. Smith Station or the construction of at least one additional new outlet from J.K. Smith.

### **Consideration of Upgrading Existing J.K. Smith Outlets**

Increasing the capacity of the existing four 138 kV outlets from the J.K. Smith Station was considered. These four outlets are:

- J.K. Smith-Dale 138 kV Line (9.5 miles)
- J.K. Smith-Fawkes 138 kV Line (14.3 miles)
- J.K. Smith-Union City-Lake Reba Tap 138 kV Line (11.6 miles)
- J.K. Smith-Powell County 138 kV Line (16.3 miles)

In addition to replacement of the conductors in the four 138 kV outlets from J.K. Smith, several other upgrades would be required to eliminate all overloads. The most significant of these facilities to be upgraded are:

- Fawkes LGEE-Clark County 138 kV LGEE Line (18.3 miles)
- Clark County-Mount Sterling 69 kV LGEE Line (12.2 miles)
- Lake Reba-Waco-Rice Tap 69 kV LGEE Line (11.8 miles)
- Dale-Hunt-J.K. Smith-Trapp 69 kV EKPC Line (11.2 miles)
- Dale-Newby #1 69 kV EKPC Line (11.1 miles)
- Powell County-Jeffersonville 69 kV EKPC Line (8.5 miles)
- Dale-Three Forks-Fawkes 138 kV EKPC Line (7.3 miles)
- Boonesboro North-Winchester Water Works-Boone Avenue 69 kV LGEE Line (5.9 miles)
- Davis-Nicholasville 69 kV EKPC Line (3.8 miles)
- Lake Reba Tap 161-138 kV, 200 MVA LGEE Transformer
- Boonesboro North 138-69 kV, 150 MVA LGEE Transformer
- Powell County 161-138 kV, 150 MVA EKPC Transformer
- Powell County 138-69 kV, 100 MVA EKPC Transformer
- Dale 138-69 kV, 82.5 MVA EKPC Transformer
- Beattyville 161-69 kV, 56 MVA LGEE Transformer
- West Irvine 161-69 kV, 50 MVA LGEE Transformer

Each of the facilities to be upgraded would need to be removed from service for construction at some point during the period from June 2006 through March 2010. This would require multiple simultaneous outages in the area, which would create significant reliability and operational concerns. Furthermore, it is not known if all of the upgrades can be completed by their needed dates, since there are more than 20 facilities requiring significant upgrades.

### **345 kV Alternatives**

Three 345 kV alternatives have been identified that may solve the capacity issues associated with the added generation at J.K. Smith. The facilities required at J.K. Smith are identical for either Alternative 1 or Alternative 2. Alternative 3 requires an additional 138 kV line exit at J.K. Smith that is not needed for either of the other two alternatives. These substation facilities at J.K. Smith can be constructed without significant difficulty. The relative constructability of the other facilities will be discussed for each alternative.

Alternative 1 includes the construction of a new 345 kV substation in the Garrard County area. This substation needs to be located near LGEE's existing Brown-Pineville double-circuit 345 kV line to minimize the amount of 345 kV line construction required to connect one of the circuits with the new 345 kV line from J.K. Smith. This alternative also calls for the construction of a new 345 kV line between the J.K. Smith Substation and the new substation in the Garrard County area. The approximate length of the new line is 35 to 45 miles depending on line routing and the location of the new 345 kV switching substation. EKPC has several existing 69 and 138 kV transmission line corridors in the area, which may be able to be utilized for rebuild and/or co-location.

Alternative 2 includes addition of all facilities required at the existing Tyner Substation to terminate the proposed J.K. Smith-Tyner 345 kV line and to add a new 345-161 kV autotransformer. Additional land would be needed in the area to construct the new 345-161 kV substation, and to connect it to the existing Tyner Substation. This alternative also includes the construction of a new 345 kV line between the J.K. Smith Substation and the Tyner Substation. The approximate length of the new line is 40 to 50 miles, depending on line routing. The area in a straight-line approximation between these two endpoints does not appear to have any large areas that are densely populated or highly developed. However, the Daniel Boone National Forest is located in a large area between these endpoints. Therefore, the routing of the new 345 kV line may require working with the United States Forest Service (USFS) to identify and select the preferred route through the USFS lands. In addition to the new 345 kV line and the new 345 kV switching substation, the addition of a 138 kV series reactor at EKPC's Dale Station is required.

Alternative 3 has many of the same physical issues as Alternative 2. The primary difference is that this alternative includes construction of a new 17.9-mile 138 kV line between J.K. Smith and LGEE's Spencer Road Substation in lieu of the addition of a series reactor at Dale Station. All of the issues discussed above in subsection 5.5.2 related to the Tyner Substation expansion and the new 345 kV line between J.K. Smith and Tyner are also applicable for this alternative. This alternative would require

expansion of LGEE's Spencer Road Substation and replacement of both 138-69 kV transformers at Spencer Road with larger units. Therefore, a significant amount of work would be required at this site to implement this alternative.

All three Alternatives require significant new 345 kV line construction. Alternative 1 includes a new 345 kV line from J.K. Smith to the Garrard County area and is expected to be 35 to 45 miles in length. Alternatives 2 and 3 both require a new 345 kV line from J.K. Smith to the existing Tyner Substation. This line is expected to be 40 to 50 miles long. This line is expected to be more difficult to construct, since the Daniel Boone National Forest is between the two endpoints. Furthermore, it is expected to have more potential impact, since it is likely to be longer and since there are less opportunities for co-location with existing lines. Also, Alternative 3 requires additional construction of approximately 18 miles of new 138 kV line. Therefore, Alternative 1 appears to have an advantage over both Alternatives 2 and 3 regarding constructability of the transmission lines, based upon a cursory analysis.

In addition to the major 345 kV and 138 kV line and substation construction, each Alternative requires some additional upgrades of EKPC, AEP, and/or LGEE facilities. As discussed earlier, Alternative 1 requires only one potential upgrade on the AEP system. Alternatives 2 and 3 both would require multiple upgrades on the AEP system. Additionally, the earlier discussion indicates that more upgrades of both EKPC and LGEE facilities would be required for Alternatives 2 and 3 than is required for Alternative 1. Therefore, a comparison of the number and expected scope of the additional system upgrades required shows that Alternative 1 holds a substantial advantage over both Alternative 2 and Alternative 3.

Therefore, based on this information, Alternative 1 appears to provide significant advantages over Alternatives 2 and 3 with regard to the physical issues associated with construction and expansion.

## **Future Expansion**

Alternative 1 specifies construction of a new 345 kV substation in Garrard County (West Garrard). The construction of the West Garrard substation will provide opportunities to step-down to 138 kV or 161 kV in the area in the future and will also provide opportunities to build 345 kV transmission into the western part of the EKPC system if necessary. This new substation will be well located in the central part of the EKPC system for opportunities to provide support into the weaker southern and western parts of the EKPC transmission system. Any future expansion involving this new substation would need to be coordinated with LGEE, due to the proposed interconnection at this point and due to the numerous interconnections throughout the two systems.

Alternatives 2 and 3 both include construction of a new 345 kV line into EKPC's existing Tyner Substation, which is located in the southeastern part of the EKPC system. Expansion of the Tyner Substation to accommodate the new 345 kV facilities is expected to be problematic due to proximity to Forest System lands. Furthermore, it may be



difficult to acquire sufficient land to allow for future expansion at this substation. Addition of 345 kV facilities at Tyner connecting it to J.K. Smith does provide valuable support to the Tyner area. However, the value of this addition for future expansion is limited. The EKPC system is expected to need support in its western portion. The additional distance from Tyner to the Garrard County area is approximately 40 miles. Therefore, if future support is needed to the west of the Garrard County area, an additional 40 miles of transmission line construction would be needed to provide it from Tyner compared to providing it from West Garrard.

Based on the location of the proposed West Garrard Substation and the possibilities for future expansion, Alternative 1 has a significant advantage over Alternatives 2 and 3. The table below summarizes the conclusions of the comparison performed for the three Alternatives that were developed. Each Alternative was given a ranking from 1 to 3 in each of the categories considered, with a score of 1 being the best score in each category and a score of 3 being the worst. The data indicates that Alternative 1 provides the best (lowest) total score for the combination of categories considered.

<b>Comparison of the Developed Alternatives</b>			
<b>Issue</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Power Flow Impacts	1	3	2
Transmission System Losses	3	2	1
Transient-Stability Impacts	1	3	2
Short-Circuit Impacts	1	1	1
Physical Issues	1	2	3
System Reliability	3	2	1
Future Expansion	1	3	2
Costs	1	2	3
Performance for Double Contingencies	2	3	1
<b>Total Score</b>	<b>14</b>	<b>21</b>	<b>16</b>

## **Section 7: Conclusions and Recommendations**

The following conclusions are based on the analysis contained in the SIS:

- The existing four 138 kV transmission lines connected to the J.K. Smith Substation are not sufficient to accommodate additional generation at the J.K. Smith site. Furthermore, the planned addition of the new J.K. Smith-North Clark 345 kV line and associated facilities at J.K. Smith do not provide significant additional outlet capability for the J.K. Smith generation.
- Upgrading the existing outlets from the J.K. Smith Station is not a practical solution for a number of reasons. First, a large number of additional facilities are overloaded and would also need to be upgraded. Additionally, the outages necessary to perform these upgrades within the necessary timeframe could result in severe operational problems. Furthermore, the scope and cost of these



- upgrades is very uncertain. Also, upgrading existing lines does not provide significant transmission capacity margins, particularly when multiple facility outages are occurring on the transmission system. Finally, upgrading existing transmission facilities does not reduce transmission losses as effectively as adding additional transmission facilities does.
- A large number of new transmission outlets from J.K. Smith were evaluated, but were eliminated because the outlet did not either eliminate a substantial number of thermal overloads or the outlet did not provide any significant additional benefits compared to shorter and/or less expensive outlets.
  - The studies determined that transmission plans that only include 138 kV outlets from J.K. Smith are not viable, since at least three 138 kV outlets would be required, a significant number of transmission-system upgrades would still be required, and transmission-system losses would not be significantly reduced.
  - Two 345 kV outlets were determined to have the greatest impact on the thermal overloads identified with the proposed generators. These are the J.K. Smith-West Garrard 345 kV line and the J.K. Smith-Tyner 345 kV line. One transmission plan that includes J.K. Smith-West Garrard and two plans that include J.K. Smith-Tyner were developed.
  - Comparison of the three Alternatives in nine categories indicates that Alternative 1 is the optimal transmission plan. Since this is also the lowest cost plan, Alternative 1 is recommended for implementation.

Based upon the information contained in the SIS, it is recommended EKPC construct the Smith-West Garrard 345 kV project (Alternative 1).